FINAL REPORT
MAY 2005

REPORT NO. 05-12

TRANSPORTABILITY TESTING OF THE JOINT DIRECT ATTACK MUNITION (JDAM) PACKED IN A CNU-589 SHIPPING AND STORAGE CONTAINER USING VINYL DUNNAGE AIR BAGS, TP-94-01, REVISION 2, JUNE 2004 "TRANSPORTABILITY TESTING PROCEDURES"

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MCALESTER, OKLAHOMA 74501-9053

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REPORT NO. 05-12 **May 2005**

TRANSPORTABILITY TESTING OF THE JOINT DIRECT ATTACK MUNITION (JDAM) PACKED IN A CNU-589 SHIPPING AND STORAGE CONTAINER USING VINYL DUNNAGE AIR BAGS, TP-94-01, REV. 2, JUNE 2004, "TRANSPORTABILITY TESTING PROCEDURES"

ABSTRACT

The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAC-DEV), was tasked by Naval Surface Warfare Center to conduct transportability testing on the Joint Direct Attack Munition (JDAM) packed in CNU-589 shipping and storage containers when secured using vinyl air bags as dunnage. The air bags were manufactured by Centerload Shipping Technologies, Hayward, CA. Polyester strapping was used to secure the JDAM CNU-589 containers in a stack. The polyester strapping was manufactured by Polychem Corporation, Mentor, OH. The testing was conducted in accordance with TP-94-01, Revision 2, June 2004 "Transportability Testing Procedures." The testing included Hazard Course, Road Trip, and Panic Stops.

The objectives of the testing were to evaluate the use of vinyl air bags as dunnage and to evaluate the use of polyester strapping for shipping the JDAM CNU-589 containers by commercial trailers. The interface between the vinyl air bags and steel strapping was also evaluated.

The testing conclusions are:

1. The vinyl air bags and polyester strapping adequately held the JDAM CNU-589 containers in place.
2. Doubled 2" x 6" nailed floor line dunnage should be placed between each JDAM CNU-589 container stack to prevent stair casing and movement in the longitudinal direction.
3. The steel strapping did not damage the vinyl air bags.
4. Additional polyester strapping was required for the JDAM CNU-589 container stack at the door end of the trailer. The strapping was added to

prevent movement in the lateral direction. Therefore, the stack of JDAM CNU-589 containers was strapped in both the lateral and longitudinal direction.

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VALIDATION ENGINEERING DIVISION
MCALESTER, OK 74501-9053

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TRANSPORTABILITY TESTING OF THE JOINT DIRECT ATTACK MUNITION (JDAM) PACKED IN A CNU-589 SHIPPING AND STORAGE CONTAINER USING VINYL DUNNAGE AIR BAGS, TP-94-01, REVISION 2, JUNE 2004 "TRANSPORTABILITY TESTING PROCEDURES"

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PART 1 – INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center (DAC), Validation Engineering Division (SJMAC-DEV), was tasked Naval Surface Warfare Center to conduct transportability testing on the Joint Direct Attack Munition (JDAM) packed in CNU-589 containers when secured using vinyl air bags as dunnage. The air bags were manufactured by Centerload Shipping Technologies, Hayward, CA. Polyester strapping was used to secure the JDAM CNU-589 containers in a stack. The polyester strapping was manufactured by Polychem Corporation, Mentor, OH. The testing was conducted in accordance with TP-94-01, Revision 2, June 2004 "Transportability Testing Procedures." The testing included Hazard Course, Road Trip, and Panic Stops.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Joint Munitions Command (JMC), Rock Island, IL. Reference is made to the following:

1. AR 740-1, 15 June 2001, Storage and Supply Activity Operation.

2. OSC-R, 10-23, Mission and Major Functions of U.S. Army Defense Ammunition Center (DAC) 21 Nov 2000.

C. OBJECTIVE. The objectives of the testing were to evaluate the use of vinyl air bags as dunnage and to evaluate the use of polyester strapping for shipping the JDAM CNU-589 containers by commercial trailers. The interface between the vinyl air bags and steel strapping was also evaluated.

D. CONCLUSION.

1. The vinyl air bags and polyester strapping adequately held the JDAM CNU-589 containers in place.

2. Doubled 2" x 6" nailed floor line dunnage should be placed between each JDAM CNU-589 container stack to prevent stair casing and movement in the longitudinal direction.

3. The steel strapping did not damage the vinyl air bags.

4. Additional polyester strapping was required for the JDAM CNU-589 Container stack at the door end of the trailer. Strapping was added to prevent movement in the lateral direction. Therefore, the stack of JDAM CNU-589 containers was strapped in both the lateral and longitudinal direction.

PART 2 - ATTENDEES

ATTENDEE	MAILING ADDRESS
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Mark Caires 1-800-304-0031	Centerload Shipping Technologies 3165 Diablo Avenue Hayward, CA 94545

PART 3 - TEST EQUIPMENT

1. Joint Direct Attack Munition (JDAM) packed in a CNU-589 container

2. HO 48" x 48" Vinyl Dunnage Air Bags from Centerload Shipping Technologies

3. Turboinflator from Centerload Shipping Technologies

4. MPC5835 Polyester Strapping From Polychem Corporation

5. Bet 700 Polychem Power Sealess Combination Tool

6. Trailer, Cargo, 48-Foot
   Manufacturer: Stoughton Trailers, Inc.
   Date of Manufacturer: 7/95
   Gross Vehicle Weight Rating: 70,000 Lbs.
   VIN: 1DW1A4823TS969356
   Model: AVW-485T-S-WEDGE

7. Truck, Tractor, MTV, M1088 A1
   NSN: 2320 01 447 3893
   VSN: NL1FR5
   Weight: 19,340 pounds

8. Truck, Tractor, Ford L8000 Diesel
   VIN: 1FDYW82A8NVA10870
   Gross Vehicle Weight Rating: 46,000 pounds
   Production Date: 12/91

PART 4 - TEST PROCEDURES

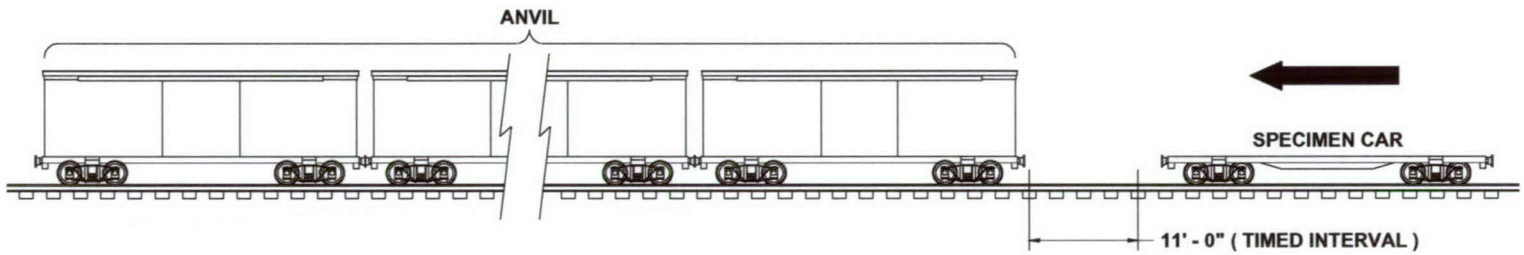
The test procedures outlined in this section were extracted from TP-94-01, "Transportability Testing Procedures," Revision 2, June 2004, for validating tactical vehicles and outloading procedures used for shipping munitions by tactical truck, railcar, and ocean-going vessel.

Inert (non-explosive) items were used to build the load. The test loads were prepared using the blocking and bracing procedures proposed for use with munitions (***see Part 6 for procedures***). The weight and physical characteristics (weights, physical dimensions, center of gravity, etc.) of the test loads were similar to live (explosive) ammunition. The following tests identified are normally required for transportability certification. However, not all tests will be required for some specific items.

A. RAIL TEST. RAIL IMPACT TEST METHOD. The test load or vehicle will be secured to a flatcar. The equipment needed to perform the test will include the specimen (hammer) car, four empty railroad cars connected together to serve as the anvil, and a railroad locomotive. The anvil cars will be positioned on a level section of track with air and hand brakes set and with draft gears compressed. The locomotive unit will push the specimen car toward the anvil at a predetermined speed, then disconnect from the specimen car approximately 50 yards away from the anvil cars allowing the specimen car to roll freely along the track until it strikes the anvil. This will constitute an impact. Impacting will be accomplished at speeds of 4, 6, and 8.1 mph in one direction and at a speed of 8.1 mph in the reverse direction. The tolerance for the speeds is plus 0.5 mph, minus 0.5 mph for the 4 mph and 6 mph impacts, and plus 0.5 mph, minus 0 mph for the 8.1 mph impacts. The impact speeds will be determined by using an electronic counter to measure the time for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars (see Figure 1).

ASSOCIATION OF AMERICAN RAILROADS (AAR)

STANDARD TEST PLAN



4 BUFFER CARS (ANVIL)
WITH DRAFT GEAR COMPRESSED AND AIR BRAKES IN A SET POSITION

ANVIL CAR TOTAL WT. 250,000 LBS (APPROX)

SPECIMEN CAR IS RELEASED BY SWITCH ENGINE TO ATTAIN: IMPACT NO. 1 @ 4 MPH
IMPACT NO. 2 @ 6 MPH
IMPACT NO. 3 @ 8.1 MPH

THEN THE CAR IS REVERSED AND RELEASED BY SWITCH ENGINE TO ATTAIN:

IMPACT NO. 4 @ 8.1 MPH

Figure 1. Rail Impact Sketch

B. ON/OFF ROAD TEST.

1. HAZARD COURSE. The test load or vehicle will be transported over the 200-foot-long segment of concrete-paved road consisting of two series of railroad ties projecting 6 inches above the level of the road surface. The hazard course will be traversed two times (see Figure 2).

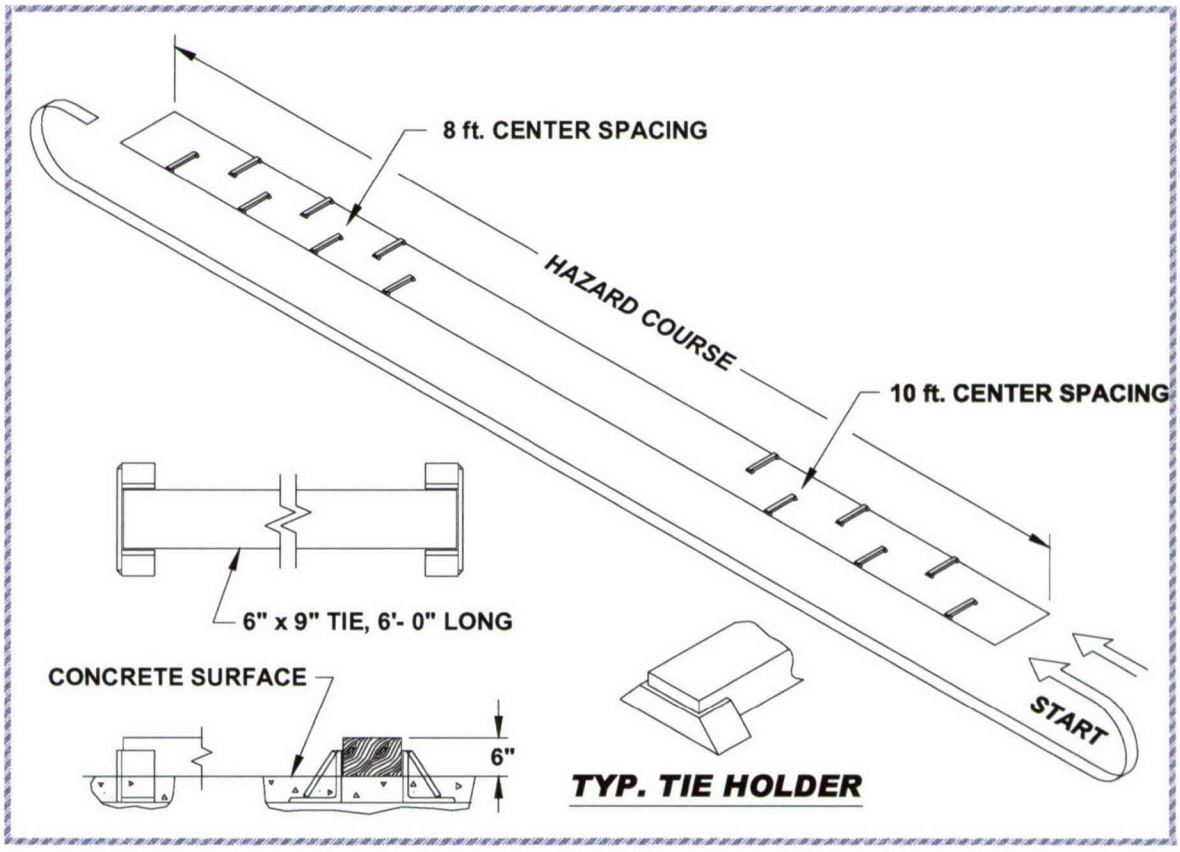


Figure 2. Hazard Course Sketch

a. The first series of 6 ties are spaced on 10-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 50 feet.

b. Following the first series of ties, a paved roadway of 75 feet separates the first and second series of railroad ties.

c. The second series of 7 ties are spaced on 8-foot centers and alternately positioned on opposite sides of the road centerline for a distance of 48 feet.

d. The test load is driven across the hazard course at speeds that will produce the most violent vertical and side-to-side rolling reaction obtainable in traversing the hazard course (approximately 5 mph).

2. ROAD TRIP. The test load or vehicle will be transported for a distance of 30 miles over a combination of roads surfaced with gravel, concrete, and asphalt. The test route will include curves, corners, railroad crossings and stops and starts. The test load or vehicle will travel at the maximum speed for the particular road being traversed, except as limited by legal restrictions.

3. PANIC STOPS. During the road trip, the test load or vehicle will be subjected to three (3) full airbrake stops while traveling in the forward direction and one in the reverse direction while traveling down a 7 percent grade. The first three stops are at 5, 10, and 15 mph while the stop in the reverse direction is approximately 5 mph. This testing will not be required if the Rail Impact Test is performed.

4. WASHBOARD COURSE. The test load or vehicle will be driven over the washboard course (see Figure 3) at a speed that produces the most violent response in the vertical direction.

C. OCEAN-GOING VESSEL TEST. 80-DEGREE TILT TEST. The test load (specimen) shall be positioned on level terrain with the bottom corner fittings resting on timbers so the entire container is supported solely by the bottom corner fittings. The timbers shall be oriented parallel to the end rails of the container and extend 2 feet beyond the corner fittings on each side. Using two mobile cranes and appropriate rigging, the container shall be rotated (tilted) using the bottom corner fittings on one side as a fulcrum. The rigging (slings) of one

crane shall be attached to the bottom corner fittings of the long side and the rigging (slings) of the second crane shall be attached to the top corner fittings on the opposite side. The tilting shall be accomplished by lifting the bottom corner fittings with the first crane so the container rotates about the opposite bottom corner fittings (fulcrum). Lifting/rotating by the first crane is continued until the center of gravity passes over the fulcrum, at which point the second crane shall provide support to the container and lower the container to the 80 degrees, plus or minus 2 degrees position. Rotation shall be accomplished smoothly at a slow speed so the container sidewall is subjected only to the static force of the interior load. The crane booms shall be adjusted to maintain a rear vertical suspension of the rigging at all times. In the case of end-opening type containers, at least one door (lower side of tilted container) must be closed and fastened throughout the test. The container shall be held in the tilted position for a minimum of two minutes. At which time, observations of both the container structure and the interior load shall be made. When the test is completed, the container shall be returned to its upright position using the same manner and care in handling.

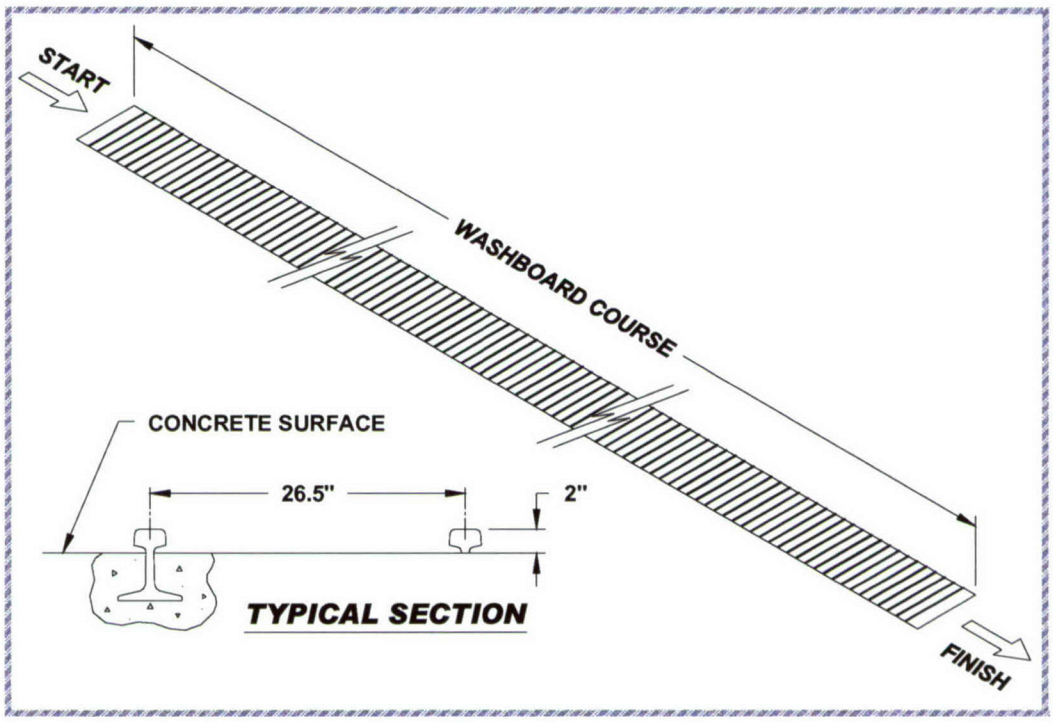


Figure 3. Washboard Course Sketch

PART 5 - TEST RESULTS

5.1

Testing Date: 26 April 2005

Test Specimen:

1. JDAM CNU-589 containers in a commercial 48-foot trailer.
2. HO 48" x 48" Vinyl Dunnage Air Bags from Centerload Shipping Technologies.
3. MPC5835 Polyester strapping from Polychem Corporation.

Test Load: 51 JDAM CNU-589 containers.

Payload Weight: 31,820 pounds.

Photo 1. Air Bags Securing the JDAM CNU-589 Containers

A. ON ROAD TESTS.

1. HAZARD COURSE.

Photo 2. Hazard Course Testing JDAM CNU-589 Shipping and Storage Containers Using Vinyl Dunnage Air Bags

Pass No.	Elapsed Time	Avg. Velocity (mph)
1	30 Seconds	5.2
2	30 Seconds	5.2

Figure 4.

Remarks:

1. Figure 4 lists the average speeds of the test load through the Hazard Course.
2. The load was not inspected following the first two passes of the Road Hazard Course due to the doors of the trailer could not be opened.

2. PANIC STOPS:

Remarks:

1. The panic stops were conducted during the Road Trip.
2. The payload was examined after the forward 15 mph panic stop. The stack of JDAM CNU-589 containers at the door end had shifted and the containers were damaged.

a. The polyester strapping remained sealed on the damaged containers but was no longer tight due to the JDAM CNU-589 container damage. The polyester strapping remained sealed and held the undamaged CNU-589 container stacks throughout the trailer.

b. Both air bags on the door end had fallen out of position due to the containers shifting from damage to the JDAM CNU-589 containers. The JDAM CNU-589 containers were damaged due to the absence of lateral strapping to prevent movement. Both air bags at the door end had holes due to a puncture from the damaged JDAM CNU-589 containers and from previous damage to the trailer liner. The air bags held the undamaged JDAM CNU-589 containers in place throughout the trailer. The interface between the air bags and the JDAM CNU-589 containers with steel strapping was examined. No damage was caused to the air bags due to the steel strapping.

3. The testing was discontinued.

Photo 3. Damaged JDAM CNU-589 Containers.

Photo 4. Damaged Air Bag.

B. <u>CONCLUSION</u>:

The polyester strapping remained sealed and held the JDAM CNU-589 containers that were not damaged. The air bags held the JDAM CNU-589 container stacks that were not damaged in place. The steel strapping did not damage the vinyl air bags.

C. RECOMMENDATION:

Additional polyester strapping should be added to the door end stack of JDAM CNU-589 containers to prevent movement in the lateral direction. This is applicable to when the stack is loaded at the door end in the lateral direction, as tested. The door end stack should be strapped to prevent movement in both the lateral and longitudinal direction.

5.2

Testing Date: 4 May 2005

Test Specimen:

1. JDAM CNU-589 containers in a commercial 48-foot trailer.
2. HO 48" x 48" Vinyl Dunnage Air Bags from Centerload Shipping Technologies.
3. MPC5835 Polyester strapping from Polychem Corporation.

Test Load: 51 JDAM CNU-589 Containers.

Payload Weight: 31,835 pounds.

Note: The JDAM CNU-589 containers are not an ammunition unit load and have not been tested or certified in accordance with MIL-STD-1660 "Military Standard Design Criteria for Ammunition Unit Loads". The containers are not able to hold up to the forces imposed during the Hazard Course Testing. The JDAM CNU-589 containers are designed for on-road transit only. Therefore, the test sequence was changed to Road Course and Panic Stops only. The Hazard Course and Washboard Course were eliminated.

A. ON ROAD TESTS.

1. ROAD TRIP:

Remarks:

1. The JDAM CNU-589 container stack at the door end of the container had stair cased onto the next row of the JDAM CNU-589 containers.
2. The passenger side air bag at the door end had moved but was still adequately restraining the load.
3. The payload had moved laterally toward the driver's side at the door end.
4. The JDAM CNU-589 containers had moved 8 inches from the closed wall of the trailer due to the stair casing of the JDAM CNU-589 container lid handles.

Photo 5. Stair Casing of JDAM CNU-589 Container Lid Handles.

Photo 6. Movement of Passenger Side Air Bag.

2. **PANIC STOPS:**

Remarks:

1. The panic stops were performed during the Road Trip.

2. During the forward 5 mph panic stop the JDAM CNU-589 containers moved 7.5 inches in the forward direction due to the stair casing of one JDAM CNU-589 container onto another.

3. During the forward 10 mph panic stop the JDAM CNU-589 containers moved an additional 4.5 inches in the forward direction due to the stair casing of one JDAM CNU-589 container onto another.

4. During the forward 15 mph panic stop the JDAM CNU-589 containers moved forward an additional 3.5 inches on the driver's side and back 1.5 inches on the passenger side due to the stair casing of one JDAM CNU-589 container onto another. The total movement was 15.5 inches from the original starting position on the driver's side.

5. The payload was not examined following the reverse 5 mph due to the pressure the payload exerted on the trailer doors.

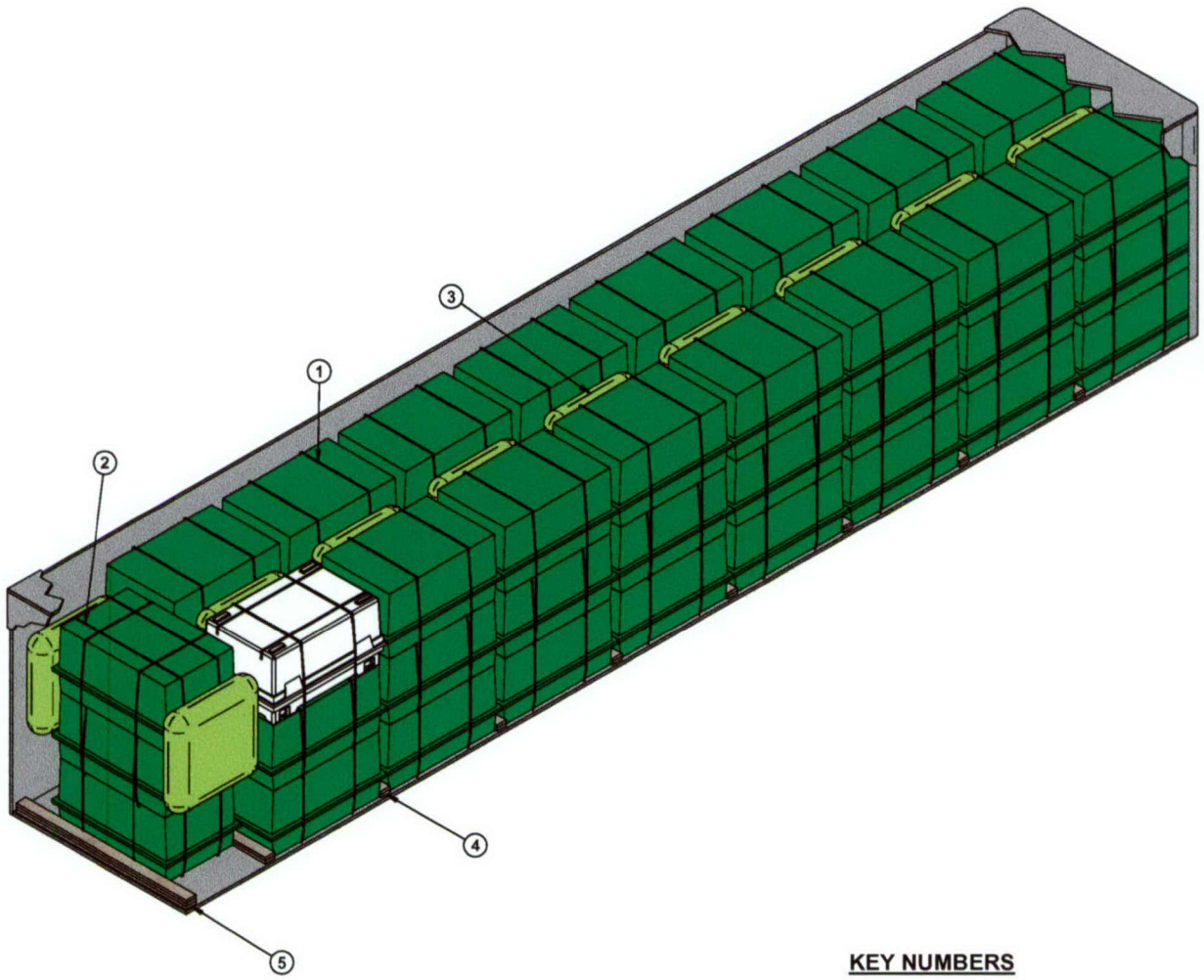
Photo 7. 15.5 Inches Total Movement from the Original Starting Position.

B. <u>CONCLUSION</u>: The air bags and polyester strapping adequately held the JDAM CNU-589 containers in place. The steel strapping did not damage the vinyl air bags.

C. <u>RECOMMENDATION</u>: Doubled 2" x 6" nailed floor line dunnage should be placed between each JDAM CNU-589 container stack to prevent stair casing and movement in the longitudinal direction.

PART 6 – DRAWINGS

The following drawing represents the load configuration that was subjected to the test criteria.



ISOMETRIC VIEW

KEY NUMBERS

① BUNDLING STRAP, 5/8" X .035" X 12'-0" LONG POLYESTER STRAPPING (68 REQD, 4 PER STACK). INSTALL TWO STRAPS TO ENCIRCLE THE BOTTOM AND MIDDLE CONTAINERS AND INSTALL ADDITIONAL TWO STRAPS TO ENCIRCLE THE MIDDLE AND TOP CONTAINERS.

② LONGITUDINAL BUNDLING STRAP, 5/8" X .035" X 21'-11" LONG POLYESTER STRAPPING (4 REQD). INSTALL TWO STRAPS TO ENCIRCLE THE BOTTOM AND MIDDLE CONTAINERS AND INSTALL ADDITIONAL TWO STRAPS TO ENCIRCLE THE MIDDLE AND TOP CONTAINERS. NOTE: LONGITUDINAL BUNDLING STRAPS ARE ONLY REQUIRED FOR THE LATERALLY POSITIONED STACK OF CONTAINERS AT THE REAR OF THE LOAD.

③ VINYL DUNNNAGE AIR BAG, 48" X 48" (10 REQD). PLACE BETWEEN LATERALLY ADJACENT STACKS OF CONTAINERS AND ON BOTH ENDS OF LATERALLY POSITIONED STACK AT THE REAR OF THE TRAILER. POSITION SO AS TO ACHIEVE EQUAL SURFACE CONTACT BETWEEN THE TOP AND THE MIDDLE CONTAINERS. INFLATE IN ACCORDANCE WITH MANUFACTURERS' INSTRUCTIONS. NOTE: INSURE SMOOTH SURFACE ON TRAILER SIDEWALLS WHERE DUNNAGE BAGS CONTACT WALL. COVER ROUGH SURFACE AREAS WITH TAPE OR SUITABLE ANTI-CHAFING MATERIAL TO PROTECT DUNNAGE BAGS FROM PUNCTURE.

④ SEPARATOR, 2" X 6" X BY TRAILER WIDTH MINUS 2" (REF: 8'-0") (DOUBLED) (8 REQD). NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/8-10d NAILS. LAMINATE THE SECOND PIECE TO THE FIRST W/8-10d NAILS.

⑤ REAR HEADER, 2" X 6" X BY TRAILER WIDTH MINUS 2" (REF: 8'-0") (TRIPLED) (1 REQD). NAIL THE FIRST PIECE TO THE TRAILER FLOOR W/8-10d NAILS. LAMINATE THE SECOND PIECE TO THE FIRST W/8-10d NAILS. LAMINATE THE THIRD PIECE IN A SIMILAR MANNER.

BILL OF MATERIAL		
LUMBER	LINEAR FEET	BOARD FEET
2" X 6"	152	152
NAILS	NO. REQD	POUNDS
10d (3")	152	2-1/2
DUNNAGE BAG, 48" X 48" - 10 REQD		20 LBS
PLASTIC STRAPPING, 5/8" - 904'REQD		11 LBS

LOAD AS SHOWN

ITEM	QUANTITY	WEIGHT (APPROX)
CNU-589 CONTAINER	51	31,569 LBS
DUNNAGE		338 LBS
TOTAL WEIGHT		31,907 LBS (APPROX)

51 UNIT LOAD IN A 48'-0" LONG BY 8'-2" WIDE VAN TRAILER